CHAPTER 24
Habitat Enhancement Aided by Geographic Information Systems (GIS)

Alex Yee

Geographic Information Systems (GIS) is an invaluable tool for habitat enhancement. It is a computer system to capture, store, analyse and visualise spatial data. In other words, GIS is not merely *the map* used for viewing, but also the system that handles the layers of digital information that forms *the map* (Fig. 1). In the context of habitat enhancement, one could use GIS to gain a better understanding of the parks and surrounding environment, make informed decisions on the approaches to adopt, and communicate the output with stakeholders. The aim of this chapter is to provide a basic overview of GIS, so one could work effectively with a GIS personnel in carrying out the habitat enhancement work.

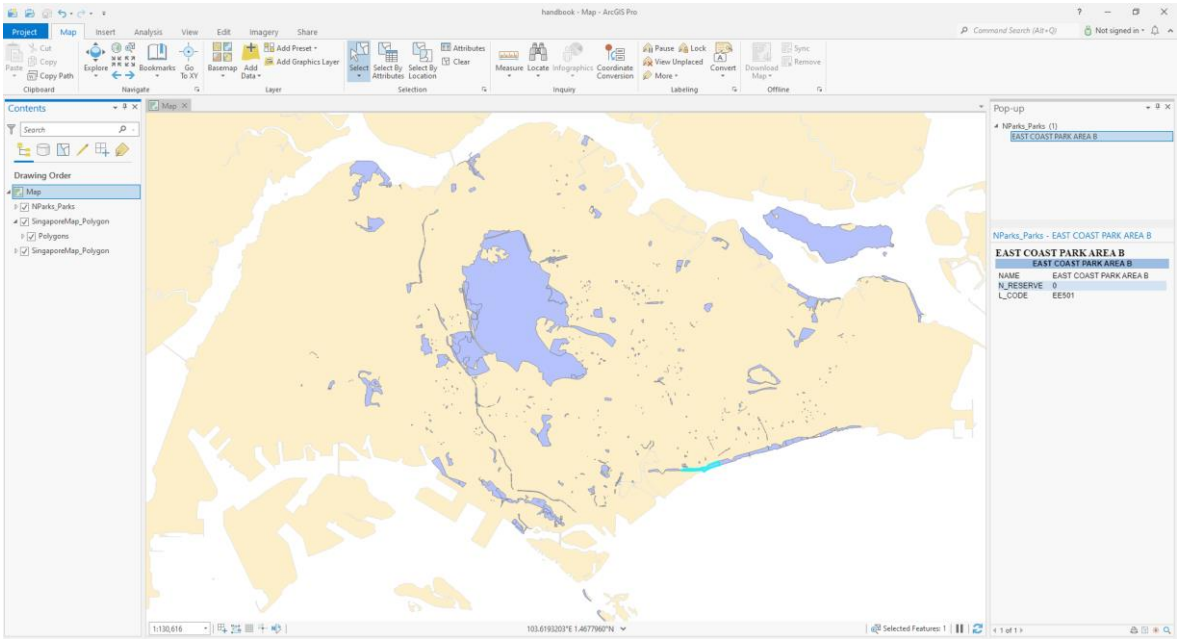

Fig. 1. Example of a GIS software interface that shows the Singapore islands and location of parks. A park was selected, and its related information was shown in the right panel.

There are some GIS operations to consider before starting a habitat enhancement project. Habitat mapping within the park and surrounding environment is the crucial first step for planning the habitat enhancement project. A key consideration for habitat mapping would be if the

enhancement project is species-specific (e.g., for endangered butterflies) or non-species-specific (e.g., improving the overall canopy complexity of the area). Another preliminary consideration would be land cover such as grass/shrubs, trees, bare ground, water, and impervious surface (Fig. 2). Additional information can be added for refinement, such as height, quality, and composition of the land cover. If the project is species-specific, the team can consult taxonomic experts to conduct hotspot mapping or species distribution modelling to identify suitable areas for habitat enhancement.

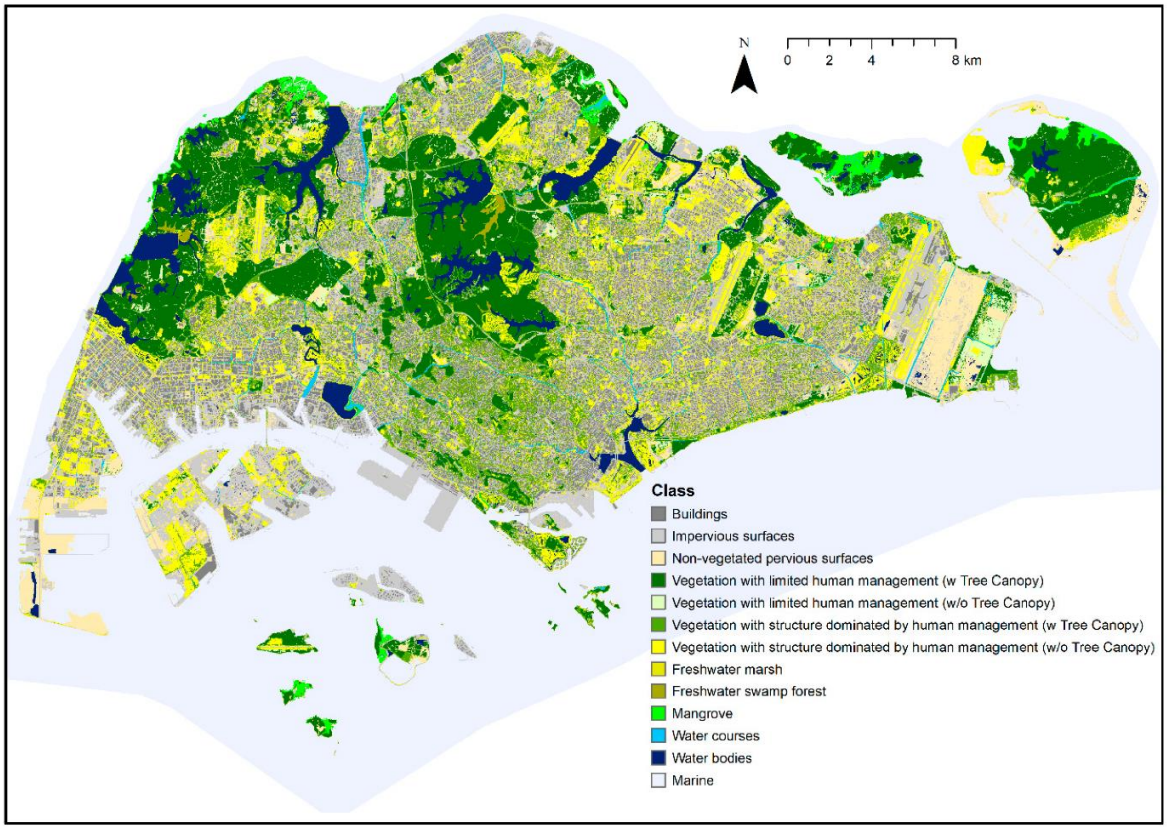

Fig. 2. An example of land cover map that can be used to represent habitat types. (Image credit: Gaw *et al.*, 2019)

Influence from the surrounding landscape would be an important factor to consider. This entails understanding if there are similar habitats in the proximity or identifying potential environment or anthropogenic stressors that need to be mitigated. This can be done in GIS by doing a buffer analysis, and its key component would be to identify a suitable buffer distance in view of the habitat enhancement objective. Examples of suitable buffer distance to consider are 126–500 metres for birds (Chong *et al.*, 2019; 2014; Wong *et al.*, 2023) and 50 metres for butterflies (Chong *et al.*, 2019).

Alternatively, one can measure via GIS the nearest distance to other habitat patches or features of interest.

Ecological connectivity. At times, the nearest distance might not be reflective of how the species could move and disperse into the habitat enhancement site owing to the presence of natural (e.g., water) or man-made (e.g., roads) barriers. The team can consider mapping the ecological connectivity of the species of interest via least-cost path analysis or similar techniques (e.g., circuit theory). This usually involves identifying the barriers in the landscape and assigning a "resistance cost" to the features. It is recommended to consult ecology or taxonomic experts to conduct this type of analysis.

Other factors to discuss with the GIS personnel include:

Software. Many commercial and free options are available. The hardware and infrastructure requirements as well as the type of GIS analysis and visualisation that they could perform should be taken into consideration. Recent advancement has also facilitated the development of interactive maps for better visual communication with stakeholders.

Data. Key questions for assessing the resources required for the GIS work:

(1) What data are needed for me to make informed decisions?
(2) Are the data available in the right format, geometry, scale, and coordinate system?
(3) When were the data acquired or last updated?
(4) What is the most effective way to acquire new data?

Data acquisition. Satellite imageries, especially those containing multispectral bands, have been frequently used to derive the land and vegetation features, although very high-resolution images (0.3 to 2 metres) would need to be purchased. Drone imagery has been increasingly used and regulations are changed regularly. It would be prudent to check with the relevant authorities on the latest regulation. Data can also be collected on the ground, such as commissioning a topographic survey for very accurate and precise geospatial data, or simply using a handheld Global Positioning System (GPS) device or smartphone for a coarser mapping.

References

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